Critical thinking taxonomy framework for radiography

We must go beyond Bloom's taxonomy to consider specific dispositions and abilities characteristic of critical thinking (Ennis 1985)

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Introduction and aim of the project

The foundation for critical thinking states 'critical thinking is a rich concept with its roots in the mid-late 20th century'. Critical thinking is identified as an important attribute in the radiography profession. Both Castle (2009) and Gosnell (2010) emphasised the importance of critical thinking abilities in the radiography profession to facilitate improved patient care outcomes, for clinical reasoning, judgement and problem solving. The advancement in imaging technology and equipment, complex imaging procedures and patients with unique challenges due to chronic illnesses and obesity further support critical thinking in this profession (Gosnell 2010). Panettieni (2015) indicates that radiography students must be able to ask questions, solve problems, interpret patient information, communicate effectively and be open-minded − all characteristics of critical thinking. The same author further indicates that the ability to apply critical thinking closes the gap between theory and clinical practice.

After a programme review at a university of technology in 2018, the Professional Board for Radiography and Clinical Technology (RCT) concluded that the teaching, learning and assessment activities in the programme may not include the higher order thinking levels (e.g. on the revised Blooms taxonomy levels three to six) as required of qualifications on level eight. This possible shortcoming has the potential to ill equip students with attributes and competencies such as critical thinking and problem solving. A study to assess the ability of third year radiography students to apply critical thinking at another university in South Africa, showed a limitation among this group of students (Pieterse, Lawrence & Friedrich-Nel 2016).

The aim of the project is to compile a critical thinking taxonomy framework for radiography to address the question: in what way can a taxonomy framework capture teaching, learning and assessment activities help to address the higher order skills, such as critical thinking, for radiography students? The objectives/sub-questions are:

- What methods must be used to teach critical thinking?
- What methods must be used to assess critical thinking?

- What are the barriers in teaching and assessing critical thinking?

Methods and processes

A qualitative analysis of relevant literature (Appendix III) was used to compile a working definition of critical thinking for radiography and to address the objectives/sub-questions:

> *A self-regulated radiographer/radiography student must apply professional knowledge (cognitive domain), clinical experience (skills) and ethical standards (affective domain) to interpret, analyse, evaluate, explain and judge concepts and information for improved patient-centred care and outcomes* (Appendix I).

To underpin this project, critical thinking was related to the deep learning levels (four to six) of Bloom's taxonomy (four to six), as well as the relational and extended abstract categories of the SOLO taxonomy (Biggs n.d.). Information from the taxonomies were linked to the three domains of critical thinking were used as a guideline to compile the critical thinking taxonomy framework (Appendix II):

- professional knowledge (head – cognitive domain): Beyer 1988; SOLO taxonomy; Krathwohl 2002 revised Blooms taxonomy; Gamble 2009.
- clinical experience (hands - psychomotor domain, competence): Miller 1990.
- ethical behaviour (affective domain: heart/metacognition): Krathwohl et al 1964; Krathwohl 2002 revised Blooms taxonomy.

Outcome

Critical thinking is a mode of thinking. A critical thinker is regarded as a person who questions, gathers information, is open-minded, a problem solver and communicates effectively (The foundation for critical thinking n.a.). Evident from the number of definitions of critical thinking (Appendix I), there are also many opinions about the teaching and assessment of critical thinking. It is furthermore important to note that the focus of this project is on teaching and assessing the application of critical thinking and does not include the inherent ability to think critically, measured with the *Watson-Glacier Critical Thinking Appraisal*© measure.

In this section information to inform the three sub-questions to support the taxonomy framework (Appendix II) is provided.

For successful teaching, critical thinking needs to be integrated and constructively aligned with teaching, learning and assessment activities and tasks. Critical thinking is said to be developed

and scaffolded over time through a variety of teaching methods to stimulate deep learning and higher-order thinking (Gosnell 2010). Duron et al (2006) recommend the five-step model to facilitate critical thinking. Step one determines the learning outcomes with the relevant action verbs. In step two teaching takes place through questioning. Step three entails practice through active learning and step four is to review, refine, improve by monitoring class activities and obtaining feedback from students while they learn to monitor their own learning. Finally, step five is to provide feedback and assessment of learning. The cycle continues by implementing step one again.

Both Hackworth (2009) and Duron, Limbach and Waugh (2006) support active teaching and a student-centred approach. Examples are interactive class discussions and Socratic questioning (Hackworth 2009). Questions need to contain the relevant level of complexity, constantly probing 'why'. More examples are collaborative learning, simulation, role-play, case study-based learning, reflection, reflective practice and debriefing. These methods involve 'reflection-in-action' and metacognition (thinking about thinking) to develop higher order skills such as critical thinking (Gum, Greenhill & Dix 2011). Work-based learning and real-life exposure to the patient in the clinical environment develop the students' ability to interact with the patient and develop associated cognitive skills, psychomotor abilities and qualities (Adler & Carton 2007). The evaluation of images to identify the anatomy and interpret the normal and abnormal patterns on the images and to produce quality images is particularly valuable (Panettienni 2015).

Assessment of critical thinking must be constructively aligned with the teaching methods and the learning outcomes. The action verbs must be relevant to both the teaching practices and assessment. Also, based on the working definition, critical thinking consists of do (hands), knowledge (head) and qualities (heart). Assessment needs to focus on assessment for learning and address the three domains (Biggs n.d.; Imrie 1995).

Duron et al (2006) and Hackworth (2009) recommend a variety of assessment methods to interpret, analyse, evaluate, create and solve problems (i.e. activities on Bloom's levels four to six). Gosnell (2010) recommends case studies, concept mapping and the portfolio of evidence to include reflection (metacognition). Ennis (1985) mentions combining writing, thinking, interaction and communication with others. Miller (2010) emphasised clinical competence as an integral part of critical thinking.

Panettieni (2015) indicates that the complexity of critical thinking creates barriers in teaching and assessing critical thinking. The barriers relate to the lecturers (teachers), the available resources and students. Teachers have the tendency to 'cover content' as they may themselves be insecure about the complexity of implementing critical thinking (Hackworth 2009). The traditional lecture (talk and chalk) with the teacher who talks, questions and thinks (Duron et al 2006) does not encourage interaction and engagement and the student is a passive participant in learning. Teaching time is usually a critical factor. Unfortunately, non-traditional teaching and assessment methods are often more time-consuming to prepare, implement and apply, when compared to the 'talk and chalk' teaching methods and non-challenging recall of memorised information e.g. during a written paper assessment (Panettieni 2015). Thus, time and resources can hinder the implementation of methodologies to teach and assess critical thinking. Students often lack motivation, confidence and even prior knowledge to participate in class discussions to stimulate critical thinking.

A taxonomy framework for critical thinking in radiography (Appendix II)

The taxonomy framework with specific action verbs to facilitate teaching and assessment activities is presented in Appendix II. Table 1 is a combination of the taxonomies (colour coded) to indicate the three domains of critical thinking: cognition, competence and metacognition. Table 2 presents the taxonomy framework recommended to use as a guide to teach and assess critical thinking in radiography with the three domains horizontally and the relational (level three) and extended abstract (level four) vertically. Table 3 provides examples of skills and values attained through critical thinking.

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